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Elaphoidella quangnamensis sp. nov. (Copepoda, Harpacticoida, Canthocamptidae), a new hyporheic species from central Vietnam

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Abstract

A new species of the genus *Elaphoidella* Chappuis, 1929 has been discovered in the hyporheic zone of a stream in Quang Nam Province, central Vietnam. This represents the second endemic species of *Elaphoidella* recorded in Vietnam, following *E. vietnamica* Borutzky, 1967. The newly described species, *E. quangnamensis* **sp. nov.**, is morphologically most similar to *E. brancelji* Sanoamuang & Watiroyram, 2021 from Thailand, a member of Group VIII (the *sewelli* group) sensu Lang (1948). Both species share several key morphological features, including a serrated free margin on urosomites 2–4 dorsally, anal operculum with more than 25 spinules along free distal margin, caudal rami lacking spinules on the inner margin, and similar armature on P1 and P3–P6. The new species differs markedly from *E. brancelji* in some characters: I) caudal rami parallel in the new species but slightly divergent in *E. brancelji*; II) caudal ramus length/width ratio in the new species about 1.2 times but 2.0 times in *E. brancelji*; III) base of caudal ramus with two spinules ventrally but four spinules in *E. brancelji*; IV) P1 Enp-1 about 1/2 length of Exp-2 but 2/3 in *E. brancelji*; V) P2 Enp-2 of the new species with three setae but four setae in *E. brancelji*; VI) P5 baseoendopod of the new species with prominence at insertion of seta II but absent in *E. brancelji*. The new species represents the sixth known species of *Elaphoidella* recorded from Vietnam.

Keywords

Endemic species, interstitial species, Quang Nam, stygobionts, taxonomy

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Introduction

The genus *Elaphoidella* Chappuis, 1929 (Copepoda, Harpacticoida, Canthocamptidae) is one of the most species-rich taxa among freshwater harpacticoids, with 219 described species and subspecies worldwide (Wells 2007; Mori and Brancelj 2008; Walter and Boxshall 2025). These copepods have been reported from a broad range of aquatic and semi-terrestrial habitats, including various types of epigean waterbodies, groundwater-fed springs, karstic aquifers, and cave systems (Galassi 2001; Brancelj 2002).

In recent years, an increasing number of new species have been described from Southeast Asia (SEA), particularly from Thailand, where 13 new species have been reported to date, including: *E. brancelji* Sanoamuang & Watiroyram, 2021; *E. isana* Watiroyram, Sanoamuang & Brancelj, 2021; *E. jaesornensis* Watiroyram, Brancelj & Sanoamuang, 2015; *E. ligorae* Watiroyram, Sanoamuang & Brancelj, 2017; *E. longiramus* Watiroyram, Janpong & Sanoamuang, 2022; *E. margaritae* Pesce & Apostolov, 1985; *E. namnaoensis* Brancelj, Watiroyram & Sanoamuang, 2010; *E. paraaffinis* Watiroyram, Sanoamuang & Brancelj, 2017; *E. phuphamanensis* Boonyanusith, Brancelj & Sanoamuang, 2024; *E. propecabezasi* Boonyanusith, Brancelj & Sanoamuang, 2024; *E. sanoamuangae* Watiroyram & Brancelj, 2016; *E. stygobiotica* Watiroyram & Koompoot, 2023; *E. thailandensis* Watiroyram, Brancelj & Sanoamuang, 2015 (Watiroyram et al. 2023; Boonyanusith et al. 2024).

To date, five species of *Elaphoidella*, one of them with two subspecies, have been recorded from Vietnam: *E. bidens coronata* (Sars G.O., 1904), *E. bidens decorata* (Daday, 1901), *E. grandidieri* (Guerne & Richard, 1893), E. *intermedia* Chappuis, 1931, *E. javaensis* Chappuis, 1928, and *E. vietnamica* Borutzky, 1967 (Watiroyram et al. 2017). This represents a relatively modest number compared to Thailand, where 16 species have been documented so far (Watiroyram 2021). *Elaphoidella vietnamica* Borutzky, 1967 was the only species described as new to science from groundwater habitats in northern Vietnam. However, the species diversity of *Elaphoidella* in Vietnam may have been underestimated due to insufficient sampling of microhabitats in groundwater environments, particularly in hyporheic zones of rivers and in caves, and the lack of comprehensive coverage across the country. Consequently, knowledge of this genus in Vietnam remains limited.

In this study, we provide a detailed morphological description of a new *Elaphoidella* species, discovered during a survey on Copepod diversity in streams located in several mountain districts of Quang Nam Province, the central Vietnam.

Materials and methods

Specimens of the new *Elaphoidella* species were collected from the hyporheic zone of a stream in Tra Duong Subdistrict, Bac Tra My District, Quang Nam Province, Central Vietnam (Fig. 1). Sampling site is situated in a hilly area at an elevation of approximately 90 meters above sea level. Specimens were collected using the Karaman-Chappuis method

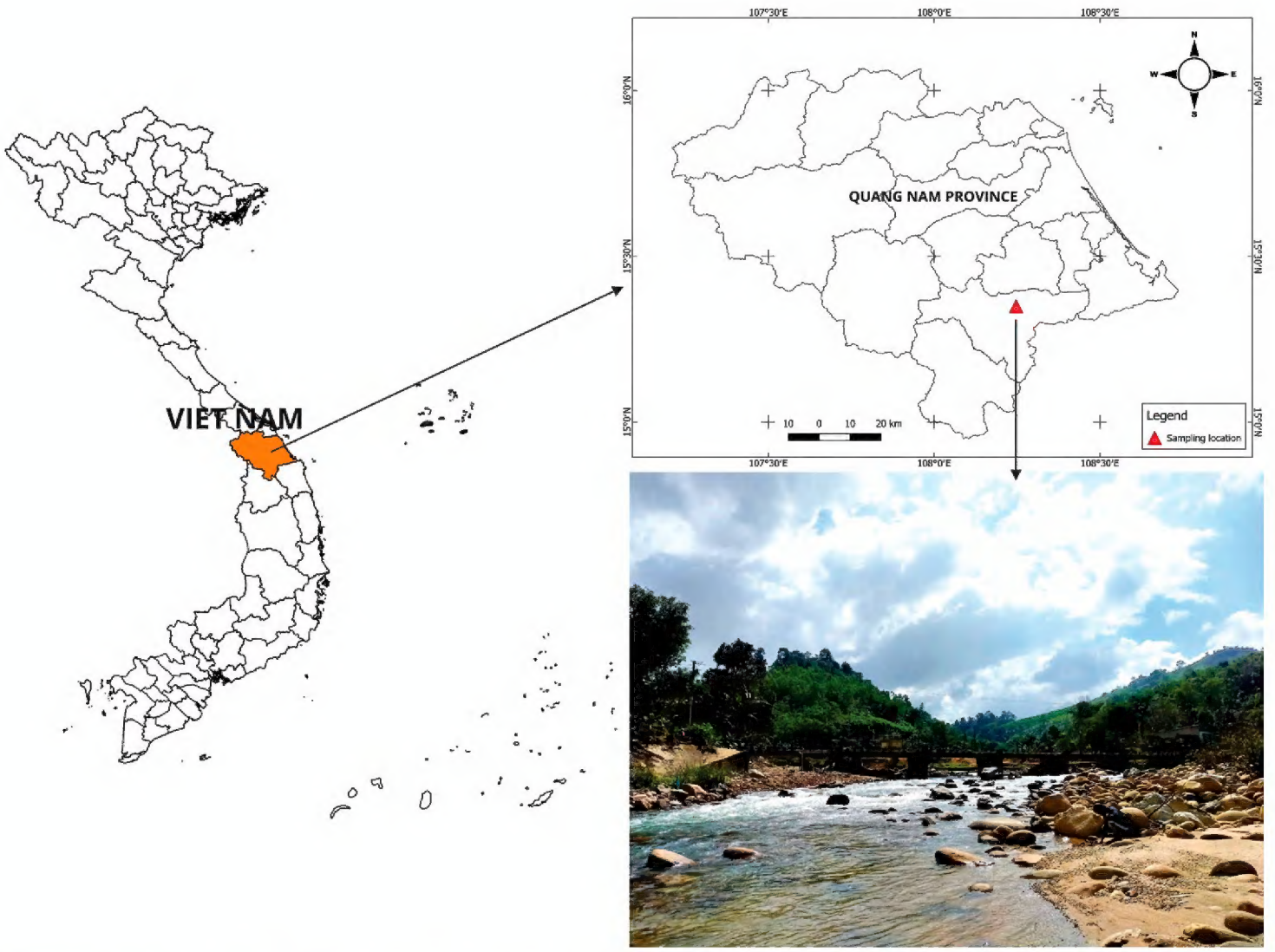

Figure 1. The sampling location of *Elaphoidella quangnamensis* sp. nov.

(Chappuis 1954). A hole with a diameter of about 100 cm was dug about one meter from the stream to reach the water table. Samples were filtered through a filtering bottle equipped with a 60 μm mesh (Brancelj 2004), and then transferred into plastic bottles. Immediately after sampling, the specimens were fixed in 4% formaldehyde solution.

The specimens were mounted in glycerin on microscope slides. Dissections were performed under a Carl Zeiss Stemi 508 stereomicroscope at 40 times magnification. Observations were then conducted under 40–100 times magnification. Dissected parts were compressed using cover glasses and sealed with transparent nail polish around the edges. Images of the body and appendages were captured using an Axio Lab A1 Carl Zeiss compound microscope equipped with a camera, at magnifications of 400–1000 times. All illustrations were prepared using CorelDraw graphics software, version 19.0.

Abbreviations used for the morphological description are as follows: ae = aesthetasc; Enp = endopod; Exp = exopod; Enp-1(2) = proximal (distal) segment of the Enp; Exp-1 (2, 3) = proximal (middle, distal) segment of the Exp; P1–P6 = first to sixth swimming legs; CR = caudal ramus. Seta I–VII = first to seventh caudal ramus seta; seta I = anterolateral accessory seta; seta II = anterolateral seta; seta III = postereolateral seta; seta IV = outer terminal seta; seta V = inner terminal seta; seta VI = terminal accessory seta; seta VII = dorsal seta. The terminology used for the caudal setae (I–VII) follows Huys and Boxshall (1991).

Taxonomy

Order Harpacticoida Sars, 1903
Family Canthocamptidae Brady, 1880
Genus *Elaphoidella* Chappuis, 1929

***Elaphoidella quangnamensis* sp. nov.**
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Etymology. The specific name refers to Quang Nam Province, where the species was discovered. Latin suffix -ensis, meaning "from", hence *quangnamensis* refers to from Quang Nam.

Type locality. Hyporheic zone of the Vu Gia stream (15°22'41"N, 108°15'33"E, 90 m a. s. l.) in Tra Duong Subdistrict, Bac Tra My District, Quang Nam Province, central Vietnam (Fig. 1).

Material examined. ***Holotype*:** • adult female, completely dissected and mounted on one slide; deposited in the Zoological Collection of Duy Tan University, Da Nang City, Vietnam (access No: ZC-DTU-COPEPODA-0014). ***Paratypes*:** • five females stored in 70% alcohol (access No: ZC-DTU-COPEPODA-0015). All material collected by Ngoc-Son Tran on March 20, 2024, in the hyporheic zone of the Vu Gia stream.

Description of female. Body length (holotype), measured from anterior margin of rostrum to posterior margin of caudal rami 410 μm (n = 6; 361–477 μm, mean = 420 μm). Habitus (Fig. 2A) elongated, subcylindrical, tapering posteriorly. Rostrum small, curving backward. Cephalothorax wider than the rest of the body, with well discernible integumental window with three lobes. Prosomites 2–4 with serrated hyaline frill. First to fourth urosomites with serrated hyaline frill dorsally and laterally (Fig. 2A, B). Somite of genital double-somite completely fused (Fig. 2F), about 0.8 times as long as wide, with several rows of spinules on latero-ventral side. Genital complex with large copulatory pore, sclerotized, bell-shaped; seminal receptacles small, well sclerotized, symmetrical. Anal somite with row of small spinules on proximal part, circumvent the somite. Pair of sensilla at base of anal operculum dorsally. Several strong spines laterally at 1/2 length of somite. Row of thin spinules on both side of anal sinus. Two strong spines near inner corner of base of each caudal ramus ventrally. Anal operculum (Fig. 2C) large, slightly curved, with 38–41 fine spinules along free margin; not reaching distal end of anal somite.

Caudal rami (Fig. 2C, 2D) trapezoidal in shape, parallel, about 1.2 times as long as wide, with a small dorsal keel. Inner margin smooth. Anterolateral accessory seta (I) absent. Anterolateral seta (II) inserted at about 1/3 of caudal ramus length, with small spine near its base. Posterolateral seta (III) smooth, inserted at near 1/2 of caudal ramus length, as long as seta II, with two strong spines near its base. Outer apical seta (IV) about 2.4 times as long as caudal ramus, smooth, with large swelling at base. Inner

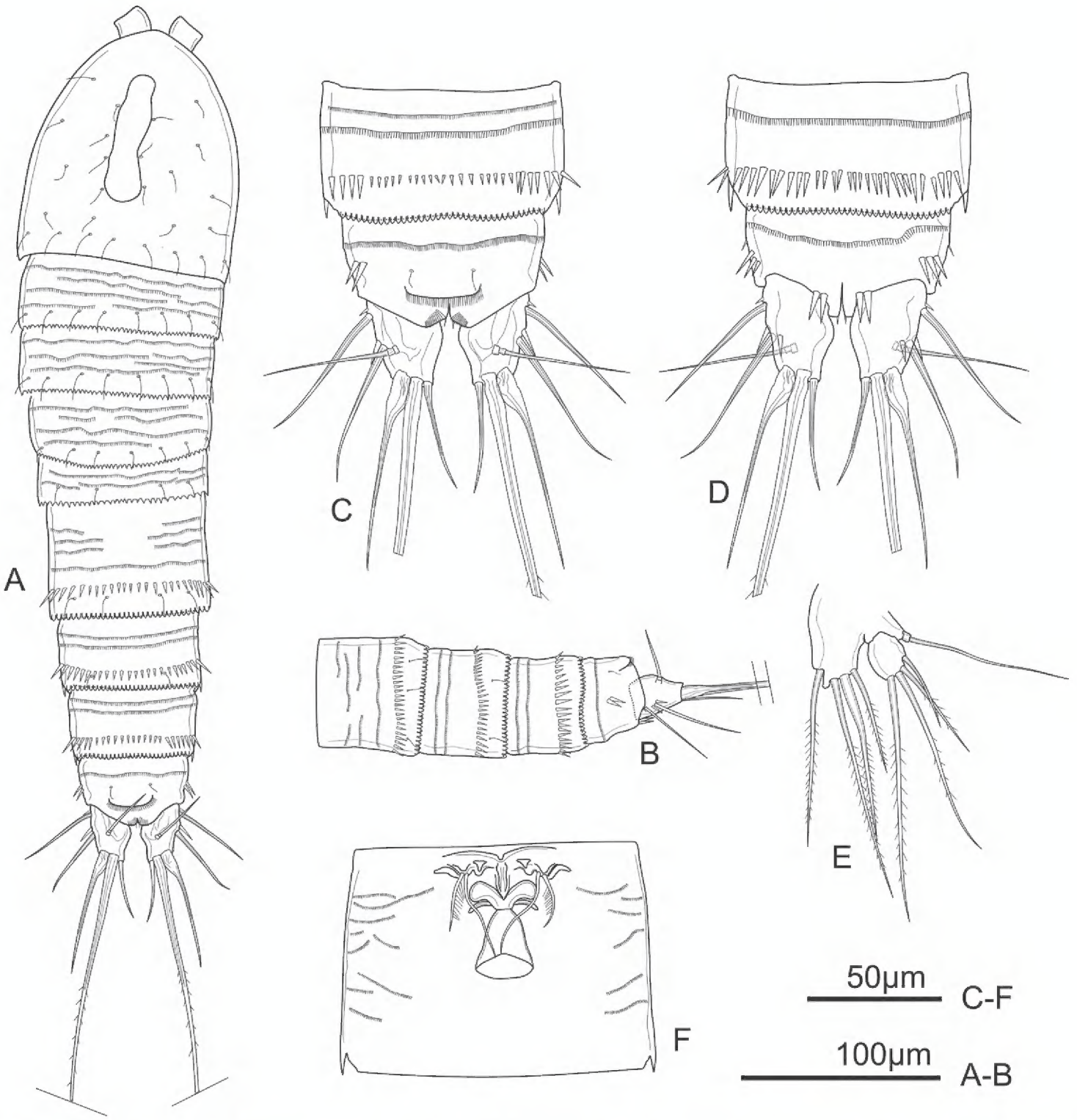

Figure 2. *Elaphoidella quangnamensis* sp. nov., female holotype **A** habitus, dorsal view **B** urosome, lateral view **C** urosomite IV, anal somite and caudal rami, dorsal view **D** urosomite IV, anal somite and caudal rami, ventral view **E** P5 **F** P6 and genital complex.

apical seta (V) longest, distal two-thirds pinnate, without fracture plane. Inner accessory seta (VI) thin, about 0.6 times as long as seta IV. Dorsal seta (VII) articulated, about 1.5 times as long as caudal ramus, inserted at 2/3 of caudal ramus length.

Antennule (Fig. 3A) relatively short, eight-segmented, not reaching posterior margin of cephalothorax. Aesthetasc on segment 4 cylindrical, with rounded tip, reached middle of distal segment. Aesthetasc on terminal segment long and slim. Setal formula as follows: 1, 9, 4, 2+ae, 1, 3, 1, 9+ae. All setae bare except that on first segment as unipinnate seta.

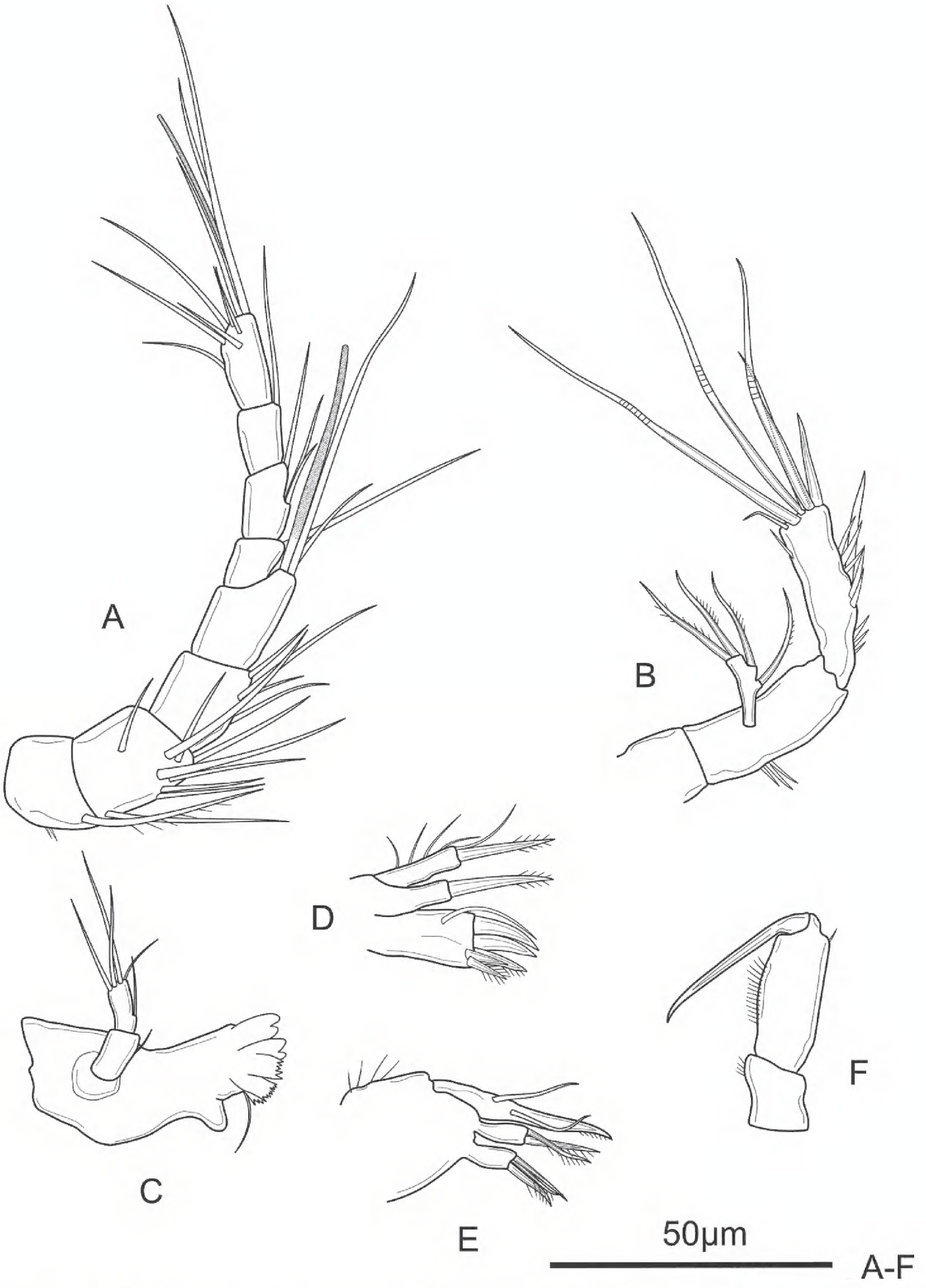

Figure 3. *Elaphoidella quangnamensis* sp. nov., female holotype **A** antennule **B** antenna **C** mandible **D** maxillule **E** maxilla **F** maxilliped.

Antenna (Fig. 3B) with short bare coxa. Allobasis about 2.6 times as long as wide; inner margin with three spinules. One-segmented Exp and Enp. Exp with one unipinnate and one bipinnate apical setae, one unipennate subapical seta, one lateral unipennate seta; all setae of subequal length. Enp with six elements apically,

from inner to outer: one spine, one smooth seta, three geniculate seta, one small bare seta; strong spine along inner margin associates with several robust spinules.

Mandible (Fig. 3C) short and robust, with five strongly chitinized teeth on gnathobase, dorsal seta near gnathobase. Mandibular palp two-segmented; first segment with one thin and short seta; second segment with one seta laterally and four setae, unequal in length, apically; all setae bare.

Maxillule (Fig. 3D) composed of robust praecoxa, coxa, and basis. Praecoxal arthrite with five strong spines on arthrite base; one bare seta on anterior surface. Spines unequal in length, all with acute tips; one bipinnate, one unipinnate and three bare. Coxa with pinnate spiniform seta. Basis with smooth seta and pinnate spiniform seta apically; four smooth setae along inner margin represent reduced Exp and Enp.

Maxilla (Fig. 3E) two-segmented, composed of syncoxa and allobasis. Syncoxa with two endites; proximal endite with two unipinnate setae and one smooth seta; distal endite with two unipinnate setae; all setae subequal in length. Allobasis drawn out into a strong serrate claw, with two bare setae near base represented Enp and Exp.

Maxilliped (Fig. 3F) comprising syncoxa, basis and Enp. Syncoxa with row small spinules on distal part along inner margin. Basis 2.4 times as long as wide, with row of spinules along inner margin, one short spinule on distal outer margin. Enp drawn out into smooth, curved claw, longer than the basis.

P1 (Fig. 4A) with three-segmented Exp and Enp. P2–P4 (Figs 4B, 5A, B) with three-segmented Exp and two-segmented Enp. Armature formula of female P1–P4 as follows (legend: inner-outer seta/spine; inner-apical-outer; Arabic numerals represent setae, Roman numerals represent spines):

Leg	**Coxa**	**Basis**	**Exp**			**Enp**		
			1	2	3	1	2	3
1	0-0	1-I	0-I	1-I	0-2+I-I	1-0	1-0	1-1+I
2	0-0	0-I	0-I	1-I	1-2+I-I	0-0	1-2	-
3	0-0	0-1	0-I	1-I	2-2+I-I	0-0	2-3	-
4	0-0	0-1	0-I	1-I	2-2+I-I	0-0	1-2	-

P1 (Fig. 4A) coxa with row of robust spinules on outer margin and row of small spinules on distal inner corner. Basis with pinnate seta on inner margin, accompanied with few robust spinules at its base; pinnate seta with two robust spinules at its base on outer margin; additional row of spinules at insertion of Enp-1. Exp-1 and Exp-2 with strong pinnate spine on outer margin. Exp-1 with several row spinules at anterior and outer margins. Exp-2 with unipinnate seta on inner margin and row spinules on outer margin. Exp-3 with row of spinules on outer margin; three elements apically: two smooth geniculate setae and one unipinnate spine; one smooth spine sub-apically. Enp-1 reach mid-length of Exp-2; one unipinnate seta at 3/4 length of inner margin; row or robust spines along outer and distal margin; several thin spinules on inner margin. Enp-2 with one seta on inner margin and a row of robust spinules along outer margin. Enp-3 about as long as Enp-2, with row of robust spinules along outer margin; one subapical seta on inner margin; two elements apically: one geniculate seta and one unipinnate spine.

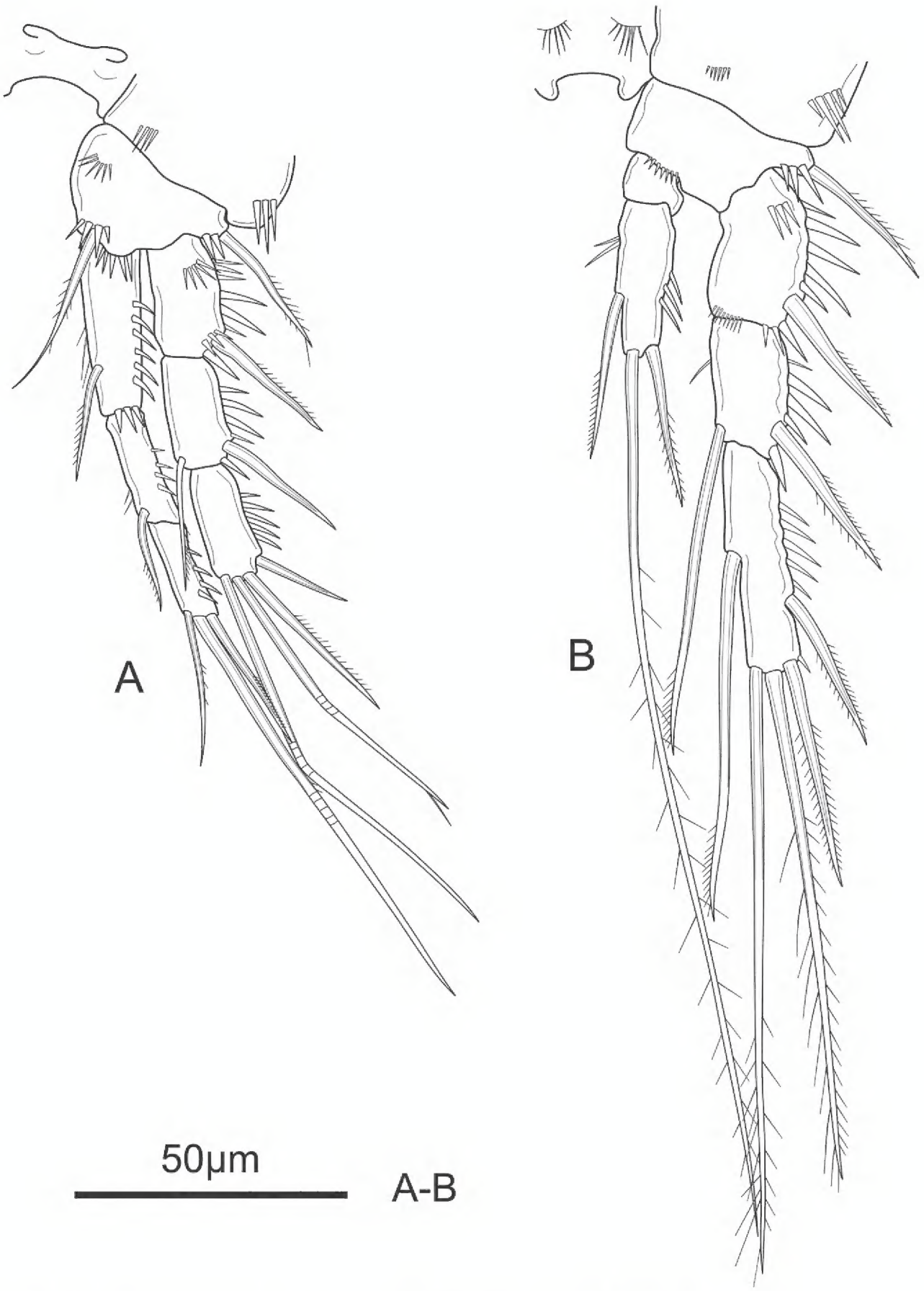

Figure 4. *Elaphoidella quangnamensis* sp. nov., female holotype **A** P1 **B** P2.

P2 (Fig. 4B) coxa with a row of robust spinules on outer margin and a row of small spinules near inner margin. Basis with unipinnate seta on outer margin and few strong spinules at its base; with a row small spinules at base of Enp-1. Exp-1 and Exp-2 with a strong spine and a row spinules along on outer margin each. Exp-1 about 1.7 times as long as wide; ornamented with row of robust spinules on anterior proximal section and a row of small spinules along distal margin; several robust spinules along outer margin. Exp-2 about as long as Exp-1, with one unipinnate inner seta. Exp-3 about 4.5 times as

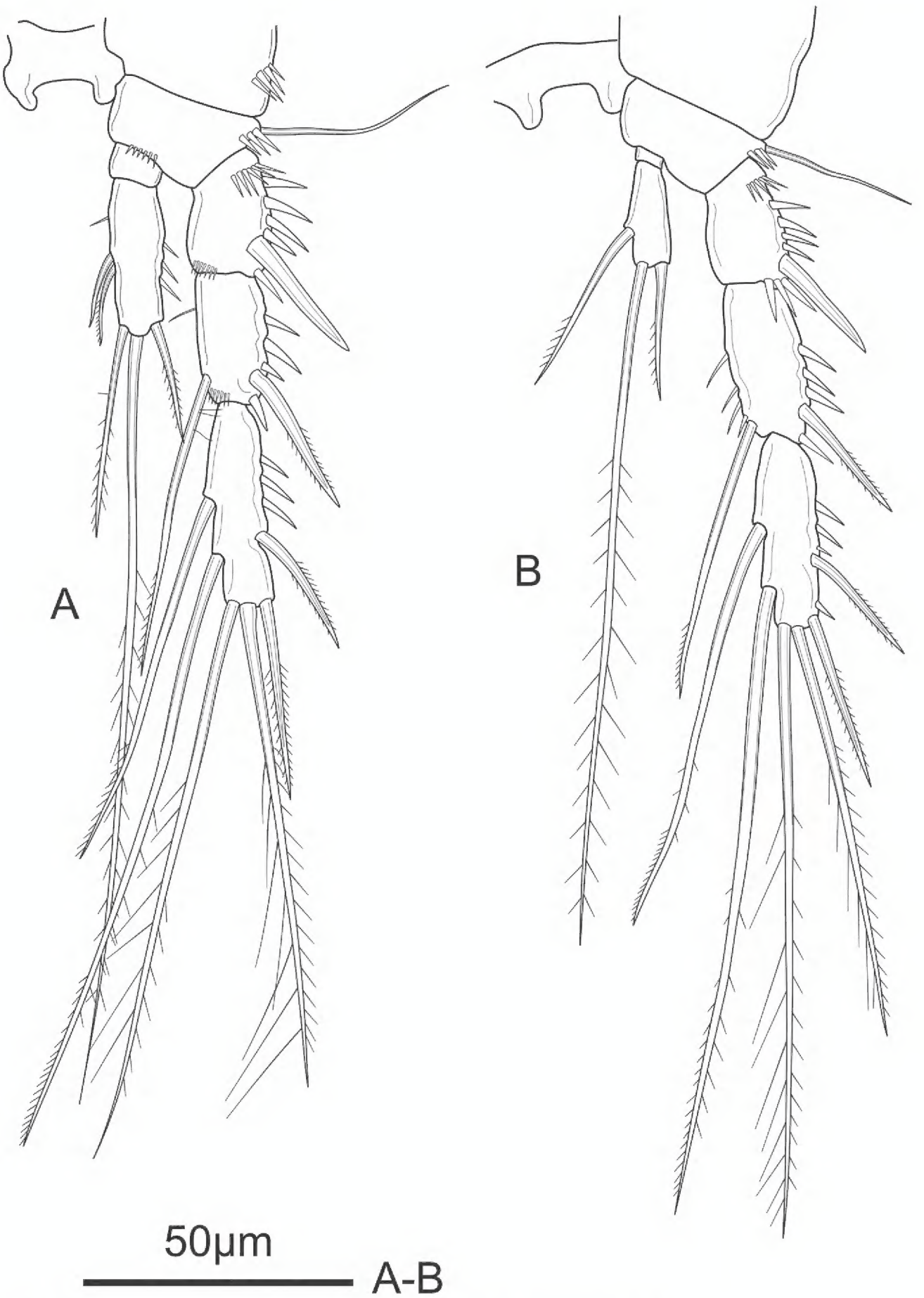

Figure 5. *Elaphoidella quangnamensis* sp. nov., female holotype **A** P3 **B** P4.

long as wide, as long as Exp-1 and Exp-2 combined; with five elements: one unipinnate seta on inner margin, two pinnate setae and one pinnate spine apically, one pinnate spine on outer margin; inner apical seta longest, about 2.6 times as long as Exp-3, outer apical seta slightly shorter than inner apical seta. Enp-1 short, about 0.7 times as long as wide, without seta on inner margin. Enp-2 about three times as long as wide, with one unipinnate seta on inner margin; one soft long seta and one spiniform seta apically.

P3 (Fig. 5A) coxa with a row of robust spinules on outer margin. Basis with long thin seta on outer margin, with few robust spinules at its base. Exp-1 and Exp-2 similar to those of P2. Exp-3 about four times as long as wide, with six elements: one unipinnate and one pinnate seta along inner margin, two plumose setae and one pinnate spine apically, one pinnate spine on outer margin at 2/3 of segment length. Enp-1 about 0.5 times as long as wide. Enp-2 about three times as long as wide; with few spinules on inner and outer margin; with five elements: one smooth and one unipinnate seta inserted close to each other at about mid-length of inner margin; three pinnate setae unequal in length apically; middle seta longest, about three times as long as Enp.

P4 (Fig. 5B) coxa unornamented. Basis similar to P3. Exp-1 with transversal row of spinules on proximal anterior surface; with strong spine on distal outer corner and row of large spinules along outer margin. Exp-2 slightly longer than Exp-1, with row of strong spinules along outer margin; one unipinnate seta on inner margin and one strong pinnate seta on outer margin. Exp-3 shorter than Exp-1 and Exp-2 combined; with six elements: two pinnate setae on inner margin; two pinnate setae and one pinnate spine apically; one pinnate spine on outer margin. Enp-1 about 0.5 times as long as wide, naked. Enp-2 about four times as long as wide; with three elements: one unipinnate seta on inner margin; one long plumose and one unipinnate seta apically; plumose seta about six times as segment bearing it.

P5 (Fig. 2E) with separated Exp and baseoendopod. Baseoendopod well-developed, reaching to distal end of Exp; with four strong pinnate setae, unequal in length: second inner one (II) longest; outermost one (IV) shortest; innermost one (I) slightly longer than second outer seta (III); with a process extending between insertion of seta I and seta II. Exp suboval in shape, 1.3 times as long as wide, with four setae: three pinnate setae apically, one smooth seta on outer margin; seta length gradually decreases from inner to outer one.

P6 (Fig. 2F) fused to somite, small, forming a simple plate, with one unipinnate seta on outer side; one smooth seta on inner side, reaching orifice of copulatory pore; inner seta longer than outer one; copulatory pore small, slightly chitinized.

Male. Not found.

Variation. P6 of female with one unipinnate seta and one smooth seta on left side, and one unipinnate setae on right side of copulatory pore as observed in one of six examined females.

Discussion

Based on morphological features of the new species including eight-segmented antennule, one-segmented exopodal antenna, two-segmented P1, two-segmented P2–P4 Enp, and P5 with four setae on both baseoendopod and Exp, the new species clearly fits within the genus *Elaphoidella*, described by Chappuis (1929, 1930). The species corresponds to Group VIII (*sewelli* group) sensu Lang (1948), characterized by the female P5 with a well-developed baseoendopod extending to distal end of Exp, accompanied by four long setae; two inner setae on P3–P4 Exp-3; P2–P4 Enp-2 with three, five, and three setae, respectively.

In total, seven *Elaphoidella* species belonging to group VIII found in SEA were compared for morphological characteristics with *E. quangnamensis* sp. nov. (Table 1). Based on the characteristics of their legs, caudal rami and the ornamentation of the dorsal hyaline frill on urosomites 2–4 and the anal operculum, *E. quangnamensis* sp. nov. is most similar to *E. brancelji* by sharing the following characteristics: I) urosomites 2–4 with serrated dorsal hyaline frill, II) caudal ramus with smooth inner margin, III)

Table 1. Comparison of morphological characteristics among species of *Elaphoidella* group VIII (*sewelli* group) sensu Lang (1948) in South East Asia (female only).

Species	No. segments on Enp P1	Length of P1 Enp-1 related to Exp P1	Setal formula on P2–P4 Enp-1	Setal formula on P2–P4 Enp-2
E. quangnamensis sp. nov.	three	1/2 of Exp-2	0:0:0	3:5:3
E. brancelji Sanoamuang & Watiroyram, 2021	three	2/3 of Exp-2	0:0:0	4:5:3
E. malayica (Chappuis, 1928)	three	tip of Exp-2	0:1:0	4:5:3
E. longiramus Watiroyram, Janpong & Sanoamuang, 2022	two	tip of Exp-2	0:0:0	2:3:0
E. sewelli (Chappuis, 1928)	three	unknown	1:1:0	4:4:3
E. thailandensis Watiroyram, Brancelj & Sanoamuang, 2015	two	tip of Exp-2	0:0:0	2:2:0
E. vietnamica Borutzky, 1967	three	unknown	0:0:0	4:4:3

Table 1. Continued.

Species	Dorsal hyaline free margin on urosomites 2–4	Length/width ratio of caudal ramus	Ornamentation on distal free margin of anal operculum	Iner margin of caudal ramus
E. quangnamensis sp. nov.	serrated	~1.2 times	38–41 fine spinules	smooth
E. brancelji Sanoamuang & Watiroyram, 2021	serrated	~ 2.0 times	more than 25 strong spinules	smooth
E. malayica (Chappuis, 1928)	smooth	~0.9 times	smooth	smooth
E. longiramus Watiroyram, Janpong & Sanoamuang, 2022	serrated	~2.0 times	six large triangular teeth	smooth
E. sewelli (Chappuis, 1928)	smooth	~1.6 times	25–30 small teeth	smooth
E. thailandensis Watiroyram, Brancelj & Sanoamuang, 2015	serrated	~1.5 times	10–11 rounded teeth	several strong lateral spinules
E. vietnamica Borutzky, 1967	serrated	~1.4 times	18–20 small spinules	smooth

Table 1. Continued.

Species	Prominence at tip of P5 baseoendopod close to seta II insertion	Swell on proximal part of seta IV on caudal ramus	No. of ventral spinules at base of caudal ramus	No. of setae on P6	Body length (μm)
E. quangnamensis sp. nov.	present	present	two	two	307–440
E. brancelji Sanoamuang & Watiroyram, 2021	absent	not present	four	two	650–780
E. malayica (Chappuis, 1928)	present	present	four to seven	unknown	750–800
E. longiramus Watiroyram, Janpong & Sanoamuang, 2022	absent	not present	seven	one	460–600
E. sewelli (Chappuis, 1928)	present	not present	five	unknown	650
E. thailandensis Watiroyram, Brancelj & Sanoamuang, 2015	absent	not present	four	one	510–540
E. vietnamica Borutzky, 1967	absent	not present	three	one	360–400

three-segmented P1 Enp, P2–P4 without seta on inner margin of Enp-1, and P4 Enp-2 with three setae. However, the new species can be distinguished from previous species by the following characters: I) P1 Enp-1 of the new species has a length equal to 1/2 Exp-2, whereas that of *E. brancelji* is about 2/3 of Exp-2; II) the seta formula on P2–P4 Enp-2 of the new species is 3:5:3 while that of *E. brancelji* is 4:5:3; III) the new species has a prominence at the tip of baseoendopod of P5 where seta II inserts but it is not present in *E. brancelji*; IV) the length/width ratio of caudal ramus is about 1.4 times in the new species and 2.0 times in *E. brancelji*; V) proximal part of seta IV of caudal ramus is swelled in the new species but not in *E. brancelji*. In addition, the caudal rami of the new species are parallel, whereas they are clearly divergent in *E. brancelji*.

In addition, *E. quangnamensis* sp. nov. can be easily distinguished from *E. vietnamica*, which was also found in the groundwaters of Vietnam (Borutzky, 1967), by the following characteristics: I) the setal formula on P2–P4 Enp-2 of the new species is 3:5:3, and 4:4:3 in *E. vietnamica*; II) proximal part of seta IV of caudal ramus is swelled in *E. quangnamensis* sp. nov. but not in *E. vietnamica*; III) the anal operculum of *E. quangnamensis* sp. nov. is ornamented with 38–41 fine spinules along the distal margin, *E. vietnamica* with anal operculum ornamented with 18–20 small spines along the distal margin; IV) *E. quangnamensis* sp. nov. has a prominence at the tip of baseoendopod of P5 where seta II inserts but it is not present in *E. vietnamica*; V) P6 of *E. quangnamensis* sp. nov. with two unequal setae, but in *E. vietnamica* with only one seta; VI) the shape of the genital complex of *E. quangnamensis* sp. nov. is large, bell-shaped copulatory pore, but it is narrow, slit-like copulatory pore in *E. vietnamica*. In the present study, only female specimens of *E. quangnamensis* sp. nov. were found, and all efforts to locate males were unsuccessful. In previously described stygobiotic *Elaphoidella* species such as *E. isana* and *E. namnaoensis* in Thailand, numerous female specimens have been collected from various localities across the country, but no corresponding males have been discovered. This raises the possibility of strict asexual reproduction, or at least a parthenogenetic mode of reproduction, in which males are extremely rare and reproduction occurs predominantly through parthenogenesis (Watiroyram et al. 2017, 2021). Parthenogenetic reproduction is often observed in groundwater-dwelling populations, where limited nutrient availability and mobility constraints may favor such a reproductive strategy. This mode of reproduction may offer an adaptive advantage to species in colonizing or persisting in such habitats (Moore et al. 2005) and may explain the widespread distribution of *Elaphoidella* species globally. Therefore, this hypothesis may also account for the absence of males in *E. quangnamensis* sp. nov. from this study.

The first new species of the genus *Elaphoidella* recorded in Vietnam was *E. vietnamica* Borutzky, 1967, which was described from a lake in cave, Lac Thuy district, Hoa Binh Province in the northern region. To date, no additional *Elaphoidella* new to science have been reported from Vietnam. Previous studies have primarily focused on groundwater habitats in the caves of the central Vietnam, while the hyporheic zone had been often overlooked in Copepoda diversity surveys (Dang and Ho 2000; Tran and Chang 2013; Tran and Hołyńska 2015; Tran and Brancelj 2017; Sanoamuang et al. 2019; Tran et al. 2021; Tran et al. 2025).

At present, six *Elaphoidella* species have been recorded in Vietnam: *E. bidens decorata*, *E. grandidieri*, *E. intermedia*, *E. javaensis*, *E. vietnamica*, and *E. quangnamensis* sp. nov. All species were collected from subterranean waters, specifically from vadose and phreatic zones in caves, as well as the hyporheic zone in the river (present study). Defaye and Dussart (2011) reported four species from Vietnam: *E. bidens bidens*, *E. grandidieri*, *E. intermedia*, and *E. javaensis*. Together with Apostolov (2007), these authors considered *E. bidens decorata* to be a synonym of *E. bidens bidens*. However, Wells (2007) and more recent publications regard *E. bidens decorata* as a valid subspecies (Sanoamuang and Watiroyram 2021; Watiroyram et al. 2022; Boonyanusith et al. 2024). Based on Apostolov's (2007) line drawing, *E. bidens decorata* appears to be the only subspecies currently present in Vietnam.

Among the 26 copepod species found in subterranean waters of Vietnam, 19 are stygobitic and 5 are interstitial species. Of these, 15 species (62.5%) are considered stygobiotic and endemic to the country (Table 2). The study of copepods living in the

Table 2. An updated number of copepod species recorded from subterranean waters in Vietnam.

Species	Habitat(s)	Ecological category	References
Calanoids			
1. *Boholina reducta* Tran & Chang, 2020*	pool in an anchialine cave	stygobite	Tran and Chang (2020)
2. *Hadodiaptomus dumonti* Brancelj, 2005*	siphon lake in a cave	stygobite	Brancelj (2005)
3. *Nannodiaptomus phongnhaensis* Dang & Ho, 2001*	river and pool in a cave	stygobite	Dang and Ho (2001)
4. *Nannodiaptomus haii* Tran & Brancelj, 2017*	river and pool in a cave	stygobite	Tran and Brancelj (2017)
5. *Neodiaptomus curvispinosus* Dang & Ho, 2001*	river in a cave	stygobite	Dang and Ho (2001)
Cyclopoids			
1. *Bryocyclops anninae* (Menzel, 1926)	pool in a cave	stygobite	Sanoamuang et al. (2019)
2. *Graeteriella* (*Graeteriella*) *longifurcata* (Tran & Chang, 2013)*	siphon lake in a cave	stygobite	Tran and Chang (2013)
3. *Mesocyclops sondoongensis* Tran & Hołynska, 2015*	siphon lake and pool in a cave	stygobite	Tran and Hołynska (2015)
4. *Metacyclops amicitiae* Kołaczynski, 2015*	hyporheic of a creek	stygobite	Kołaczynski (2015)
5. *Pseudograeteriella longiaesthetascus* Sanoamuang, Boonyanusith & Brancelj, 2019*	pool in a cave	stygobite	Sanoamuang et al. (2019)
6. *Tropocyclops chinei* Dang, 1967*	pool in a cave	stygobite	Dang (1967)
Harpacticoids			
1. *Attheyella* (*Canthosella*) *vietnamica* Borutzky, 1967	lake in a cave	stygobite	Borutzky (1967)
2. *Elaphoidella bidens decorata* (Daday, 1901)	pool in a cave	stygophile	Apostolov (2007)
3. *Elaphoidella grandidieri* (Guerne & Richard, 1893)	lake in a cave	stygophile	Borutzky (1967)
4. *Elaphoidella intermedia* (Chappuis, 1931)	lake in a cave	stygophile	Borutzky (1967)
5. *Elaphoidella javaensis* (Chappuis, 1928)	lake in a cave	stygophile	Borutzky (1967)
6. *Elaphoidella vietnamica* Borutzky, 1967*	lake in a cave	stygobite	Borutzky (1967)
7. *Elaphoidella quangnamensis* sp. nov.*	hyporheic of a river	stygobite	The present study
8. *Epactophanes richardi* Mrázek, 1893	lake in a cave	stygophile	Borutzky (1967)
9. *Microarthridion thanhi* Tran & Chang, 2012*	pool in an anchialine cave	stygobite	Tran and Chang (2012)
10. *Nitocra quangnamensis* Tran, Trinh-Dang, Nguyen & Brancelj, 2025*	hyporheic of a river	stygobite	Tran et al. (2025)
11. *Nitocra vietnamensis* Tran & Chang, 2012*	pool in an anchialine cave	stygobite	Tran and Chang (2012)
12. *Onychocamptus mohammed* (Blanchard & Richard, 1891)	pool in a cave	stygophile	Apostolov (2007)
13. *Parastenocaris sontraensis* Tran, Trinh-Dang & Brancelj, 2021*	hyporheic of a river	stygobite	Tran et al. (2021)
14. *Parastenocaris vugiaensis* Tran, Trinh-Dang & Brancelj, 2021*	hyporheic of a river	stygobite	Tran et al. (2021)
15. *Phyllognathopus viguieri* (Maupas, 1892)	lake in a cave	stygophile	Borutzky (1967)

*= endemic to Vietnam.

hyporheic zone of rivers and creeks in Vietnam remains limited compared to that found in caves, with only 5 species were reported from such habitats to date (Kołaczynski 2015; Tran et al. 2021, 2025; present study). In contrast, pools and lakes within caves are the primary subterranean habitats that have been well investigated in Vietnam (Borutzky 1967; Dang 1967; Dang and Ho 2001; Brancelj 2005; Apostolov 2007; Tran and Chang 2013, 2020; Tran and Hołynska 2015; Tran and Brancelj 2017; Sanoamuang et al. 2019). This is likely because Vietnam has a rich karst topography and is abundant in caves throughout the country (Nguyen et al. 2020), which led researchers to initially focus their surveys and studies on the cave habitats. At the same time, Vietnam possesses a dense river network with a high level of ecological diversity in the hyporheic zone, offering strong potential for discovering more stygobiotic copepods and increasing the total number of recorded species in the country (Tran et al. 2021).

Conclusion

Elaphoidella quangnamensis sp. nov. is the second species of *Elaphoidella* known to be endemic to Vietnam. It was collected from the hyporheic zone of a river in the central Vietnam. This species is one of the Vietnamese stygobitic copepods probably exhibiting parthenogenesis, with male unknown so far. The parthenogenetic condition might be proved if further and more widespread research shows that males are, indeed, entirely absent.

The new species belongs to group VIII (*sewelli* group) sensu Lang (1948) and is most similar to *E. brancelji*, a cave-dwelling species from Thailand. However, the two species can be distinguished by the key morphological characteristics, including: I) the shape and ornamentation of the caudal ramus; II) the length of P1 Enp-1; III) the number of setae on P2 Enp-2; and the shape of the P5 baseoendopod.

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